Contextual Factors associated with Information Systems in a Virtual Supply Chain

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Abstract: This paper discusses the differences between a traditional organization and a virtual organization. Different forms of virtual organizations are described to illustrate the nature of a virtual organization. The concept of a virtual supply chain is proposed and defined as a hybrid of the existing forms of virtual organizations. A virtual supply chain is then explored from an information systems viewpoint. This exploration reveals contextual factors associated with information systems in a virtual supply chain. These issues are further explored to determine how they might be addressed. Finally further research that could be conducted is proposed.

Keywords: virtual supply chain, contextual issues

Introduction

To appreciate the impact of information systems on organizations, it is necessary to review the development of information systems in organizations over the last thirty years. The development of information systems in organizations has continued unabated since the early 1970s.

The initial systems developed met the needs of individual business functions of organizations with transaction processing activities such as invoicing. The individual systems within a functional area were subsequently linked to create an integrated functional system such as an accounting system or a production system. These integrated systems provided gains in terms of efficiency and the ability to apply new techniques such as production or financial planning. Further developments enabled more integrated systems to be developed that cut across functional boundaries and facilitated the development of organization wide systems operating in a real time environment. Order processing is a classic example of an integrated system. The transaction of an order includes tasks such as order entry, stock checking, credit checking, dispatching and accounting. Different functional areas can perform each task. These organization wide systems were next linked to external systems to allow business data to be exchanged electronically.

More recent developments have witnessed a movement in the focus of web-based information systems towards the external parties, the customer and supplier. With these systems a business process can now be conducted across multiple organizations. These developments in information systems have been classified into a series of developmental phases (Table I) [2, 20, 27]:

Table I: Development Phases of Information Systems

Phase	Time	Nature
1	1970s	Computerized single function
2	1980s	Computerized functional area
3	1990s	Integrated processes across functions
4	1990s	Electronic data exchange
5	1990-2005	Internet based inter-organizational processes

The fifth phase had been dominated initially by electronic commerce systems, which permitted a customer to have access to product information, technical details and other specialist services within an organization in additional to order enquiry and order placing [15]. The application of Internet technology has created the virtual environment in which independent organizations can work together [3, 6, 7, 13, 19, 21, 25]. The enabling technology in this instance is called an extranet. This integration of systems between organizations enables the development of new business models.

Extranet

The Extranet, the most recent application of Internet technology, enables the development of private and secure networks, which supports multiple organizations in establishing relationships. These relationships are mutually beneficial to all parties in that they enable the realization of many goals [32]. The Extranet permits the creation of a virtual organization, and is of interest to organizations for several reasons: it offers more functionality at a lower cost than Electronic Data Interchange (EDI) and enables the building of closer relationships [8, 9]; sharing of information and better relationships with customers [32, 35]. EDI has

traditionally been the electronic exchange, using proprietary technology, of simple, highly structured documents and required a third party, a value-added network, to handle the accompanying fees [12]. A typical example is the bills of lading used by shipping companies, port authorities and importers and exporters.

In contrast the extranet utilizes a public network that can communicate globally with many existing organizational information systems which permits the integration of business processes [9]. The extranet will expand information availability beyond organizational boundaries and will permit users to gain access to information transparently without knowledge of which organization in which that information resides [8]. The availability of information and the effective and efficient dispersion of this information is the major reason why organizations may wish to participate within an extranet [32]. A study identifying the top 10 realized benefits of extranets (Table II) included the following benefits: enable easier access to information, in second place; increase the flexibility of information requests, in fourth place; and increase the volume of information output, in eighth place [18]. This sharing of information can take the form of internet-based information systems that facilitate the readily exchange of information to improved the efficiency and effectiveness in interorganizational activities.

Table II: Top 10 Benefits Companies Seek from Extranets Systems

1	Enhance competitiveness or create strategic advantage
2	Enable easier access to information
3	Provide new products or service to customers
4	Increase the flexibility of information requests
5	Improve customer relations
6	Enhance the credibility and prestige of the organizations
7	Provide better products or services to customers
8	Increase the volume of information output
9	Align well with stated organizational goals
10	Enable the organization to respond more quickly to change

Virtual Organization

An organization has been defined as a virtual organization when the virtual dimension of the organization's activities becomes, or is, the dominant method of conducting business [5]. Virtual dimension in this context is the performing and completion of supply chain activities, facilitated by the extranet, which previously required a physical presence. However the sharing of information and conducting business electronically across organizations is not a new phenomenon. Information systems that transcend across organizations have commonly been called interorganizational information systems [14]. The early classic examples of such interorganizational information systems (IOS) were The American Hospital Supply Corporation (AHSC) and American Airlines' (AA). The AHSC system permitted the exchange of order-processing information with customers over telephone lines and the AA system provided larger travel agencies with computerized reservation terminals [4]. Many IOS have typically been ordering systems and electronic markets linking customers, suppliers and distributors. They provided efficiency benefits, in terms of reduced postage and less data entry, with improved customer service in terms of reduced time delays and responsiveness. [34]. Although the Internet has enabled more organizations to establish IOS the nature of many systems are still primarily associated with traditional organizations.

Differences between the Traditional Organization and Virtual Organization

The differences between a traditional organization and a virtual organization can be illustrated by considering the organizing logic and organizational forms. In the traditional organization the underlying assumption is that the structure of the organization and methods of working will be in existence for a sustained period of time. In this situation the boundaries of work, the critical success factors and possible changes can be identified [5]. In contrast, a complex system, such as the virtual organization, may appear to be simple but it is premised on non-linear dynamic relationships such as feedback and/or learning curves and will only be predictable in the short-term [5]. The overriding factor that differentiates a virtual organization from a traditional organization is the reliance and dependence on the information and communications technology infrastructure rather than the bricks and mortar environment [33].

Virtual Supply Chain

In this paper, the virtual supply chain is a virtual organization with a series of value chains in which a variety of participants can contribute, either to strategic or operational activities. The contribution to the strategic activities can include establishing the mission, vision, and culture of the virtual organization. The contribution to operational activities can include the establishment of strategic business units to deal with the necessary production and marketing activities [13]. However a virtual supply chain will be considered as a particular model of a virtual organization. This model would be a hybrid model consisting of a value-alliance model, a market-alliance model and a virtual-broker model which are three of the six models of virtuality that have been proposed in an attempt to classify the various forms that a virtual organization could take [7].

The six models of virtuality are: virtual face; co-alliance; star-alliance; value-alliance; market-alliance; and virtual broker. A virtual face model is an existing organization that establishes an Internet presence in which products or services can be marketed and standard transactions performed over the Internet. A co-alliance model is the establishment of partnerships to collectively offer a product or create a service on the Internet. A star-alliance model has a dominant partner who provides a particular competency or expertise over the Internet to several partners within in a similar domain. A value-alliance model is basically either project-based, such as in a value-chain, or product-based, such as in a supply-chain with the co-ordination, in both instances, facilitated by the extranet. A market-alliance model is the collaboration, to offer a package of services or products, on the Internet, by partner organizations whose normal activities are primarily Internet based. A virtual-broker model is a dynamic network of relationships established to exploit a business opportunity to offer a unique product or service. As described above a value-alliance model can be product-based as in a supply-chain with the co-ordination facilitated by the extranet.

A virtual supply chain is the collaboration in a supply-chain, on the Internet, by a dynamic network of partner organizations whose normal activities are primarily Internet based. The objective of these partner organizations is to be able to exploit a business opportunity to offer a unique product in a timely and responsive manner.

Virtual Supply Chain and Organizational Structure

The traditional data processing activities synonymous with information systems in organizations involved interrelated components that would collect, manipulate and disseminate data and information with a feedback mechanism, to address certain business objectives [31]. These information systems included strategic, management and operational level systems that covered functional areas such as sales & marketing, manufacturing, finance, accounting and human resources [17]. In the early day of computing the transaction processing nature of the centralized computing facility supported the functional structure of the existing organizations. As personal computers and local area networks and wide area networks become more commonplace the computing systems moved towards to a distributed form and the organizational structures moved from a functional form to a divisional form. It is difficult to understand and evaluate these cause and effect iterations as there are other influencing factors including the environment, competition and technology. However a key factor in this decentralization was the support provided by the information systems that permitted the necessary communications and control features to be exercised [26]. The changes in the information systems and organization structures, in the past, have generally occurred within the relatively stable environment that traditional organizations have normally operated within. Within a virtual supply chain there are going to be two or more partner organizations. The relationships between these partner organizations will be of a temporal nature [22], the duration of which may be unknown. Within a virtual supply chain, although the relationships are of a temporal nature, it would be reasonable to deduct, based on the past, that the information systems and the organization structure would continue to influence each other and bring about the changes in how organizations position themselves. The literature would tend to support this, in part, by portraying a virtual organization as having low levels of bureaucracy and being adaptable and flexible [22, 23]. However the influence of the structure of virtual organizations on the nature of the information systems provision has revealed scant attention within the literature except to highlight that is a task of such magnitude that such systems would require a multi-disciplinary approach [10, 22]

Virtual Supply Chain and Information

The virtual supply chain, as a particular model of a virtual organization will depend on information to survive [13, 24, 36]. The nature of information in a virtual supply chain is deemed to differ from that which is provided by existing information systems. Current information systems store a static representation of an organization's information within its software systems and databases or data warehouses and tend to be inflexible and unresponsive in dynamic business environments [23]. The term 'dynamic business environments' typifies the environments within which a virtual supply chain would exist [28, 34]. To make information available to all parties in such a new type of inter-organizational system is a key challenge [1]. This challenge is to make available single accountable data that is visible and readily available to all, in a timely manner to enable decisions to be made or activities commenced. Yet within the existing literature there are very few examples of virtual organizations or virtual supply chains and the development of an informational infrastructure for such organizational forms has been described as a task of such magnitude that it requires a range of multidisciplinary skills [11]. No research base thus exists to help organizations to develop an informational infrastructure for a virtual supply chain

Information Management Issues in a Virtual Supply Chain

A basic premise in a virtual environment is that the relevant information is available to all parties. But Marshall and McKay (2000) view a virtual organization as being problematic in terms of managing the temporal relationships and the difficulty in defining the information systems requirements. The temporal relationships are defined as short-term in nature and managed within a dynamic and

changing business environment. This difficulty in the determination of the informational requirements will be due to the characteristics associated with the virtual environment, which include adaptability, flexibility, responsiveness and opportunistic behavior.

An additional problem associated with internet-based applications, such as a virtual supply chain is that information systems developers do not always know exactly who will be the partner organizations and what their information needs might be [30]. With the traditional organization the developers can interaction with users to articulate what it is they really want in terms of the information provision. Within a virtual supply chain it will be much more difficult to identify who will be the primarily partners. In this situation the developers will be reliant on their own experience to anticipate the probable information needs of the possible users.

Concerns has also been expressed about the lack of research into the organizational and management processes necessary to ensure success in the implementation of the new types of inter-organizational systems, facilitated by the extranet, that now emerging [7, 12, 16]. These concerns are about achieving a balance between being able to exercise a degree of planning and control and being able to be adaptable to changing circumstances. Adaptability at the price of not being able to plan and control activities may tend towards chaos and the result may be sub optimum performances in terms of efficiency and effectiveness.

The complications from the integration of the information systems of partner organizations within a virtual supply chain may also result in chaos unless great care is taken in the selection of partners [29]. Virtual enterprises have been described as operating on the edge of chaos with change and rapid change being about the only constant [5].

Overcoming the foregoing issues would help achieve the possible synergies in information systems and internet technology to create virtual supply chains.

Addressing Information Management Issues in a Virtual Supply Chain

Temporary relationships and Information Systems Planning

The virtual supply chain is a sequence of business alliances, which can provide access to an untapped source of competitive advantages for all the partners. The integration of business processes of the partners that provide the products, services, and information will enable all within a virtual chain to gain knowledge of how to offer better products and services and to do so while reducing their overall costs. The virtual supply chain will enable partners to share knowledge to improve the outcomes from their individual planning activities. The initial obstacle to gaining these advantages is the degree to which partners want their information systems protected from possible exploitation by other partners. Partners may have security and confidentialities concerns and thus some may place restrictions on the integration of business processes. Partners may withhold some information either because of the sensitivity of the information or as a form of self-protection. This withholding of some information could be a cause of concern as this may lead to sub-optimum performance in a virtual supply chain. Gaining the available competitive advantages may only be achieved after all the security issues associated with the establishment of a virtual supply chain have been resolved. To achieve these advantages may require partners to undergo changes in their particular business processes to allow more integration with other partners.

Sharing of information within a virtual supply chain would enrich the overall information to improve the outcomes from all planning activities. It is an expectation that the business alliances in a virtual supply chain would enable the partners to collectively influence the marketplace, but perhaps not to the extent of being a major influence.

Staff drawn from partner organizations could conduct the information systems planning activities within a virtual supply chain. This participation would be necessary to maintain a virtual supply chain as a viable entity and to enable the creation of mutual trust. Participation by all partners may be viewed as a necessity to protect their interests and to gain the maximum benefits are such that for their own organization. This might result in some loyalty conflicts between the virtual supply chain and the partner organizations. Such conflict could prevent the achievement of optimum solutions.

However this conflict can be avoided if the common business objectives of the virtual supply chain ensure a ‘win-win’ situation for all. It should be acknowledged that the aim of all partner would be to exploit the virtual supply chain but within the framework of the common business objectives.

The information systems planning activities within a virtual supply chain must be adaptable, flexible and responsive to changing requirements and conditions. This may appear very similar to that of a traditional supply chain that may exist, within a relatively stable environment. However the virtual supply chain is positioning itself to operate within a very dynamic environment, which requires unique products and services provided in a very responsive manner.

Partners and Information Needs

The determination of the information systems requirements for a virtual supply chain will be a major task necessitating active participation by all partners to ensure a consensus. This determination should be bounded by the purpose of the agreed common business objectives.

An emphasis on comprehensiveness in data collection, analysis and evaluation of alternative actions is normally an important basic feature of information systems planning. However within a virtual supply chain this would be premised on a number of conditions being satisfied. The comprehensiveness would be dependant on the objectives or vision of the partners within a virtual supply chain. If the objectives or vision were precise, concise and specific then the degree of comprehensiveness in data collection, analysis and evaluation of alternative actions may be limited. The dynamic environment that a virtual supply chain will operate within would tend to determine that comprehensiveness in the data collection, analysis and evaluation of alternative actions might not always be a realistic objective. Within a virtual supply chain an equally, if not, more important factor might be, responsiveness to the market. Addressing both factors may require an iterative approach to decision-making where decisions are revisited as more information becomes or changes are detected in the environment or key performance indices. An emphasis on comprehensiveness in information systems planning within a virtual supply chain might be a difficult goal.

An emphasis on comprehensiveness in information systems planning within a virtual supply chain may be a difficult goal to achieve and insufficient data may prevent the planning activity from being effective in meeting its objectives. Complexity in the data might arise if any data provided by partners is incomplete due to possible concerns about security of data or confidentiality issues. Complexity might also arise due to the subjective and divergent views of data of the partners. Although partner organizations might be willing to share data, the integration and aggregation activities may contribute to the complexity problem.

Organizational and Management Processes

The organizational and management processes within a virtual supply chain should have a balance between formality and flexibility. There may be a need for formality as the communications amongst the partner organizations regarding activities may not be on a daily basis and therefore there needs to be formal policies to ensure adherence to agreed practices plus a mechanism to deal with exceptional circumstances. But there could be a concern that the formality depends on the level of staff involved in virtual supply chain processes. With more senior staff the formality may conflict with their creativity. Managing a virtual supply chain is considered to be very different in comparison to a supply chain with traditional organizations. The formality associated with the activities within a virtual supply chain could be considered similar to the situation with Electronic Data Interchange, which requires formal rules, specifications, schemas and security issues to be addressed to ensure information can be shared. Before implementing a virtual supply chain it may be necessary for all partner organizations to agree standards and procedures and in particular the policies in order that the partner organizations know what is being done and how. However it should be acknowledged that information must be readily exchanged amongst partner organizations to gain consensus and for problem resolution. This implies that within a virtual supply chain there will be a greater flow of information in contrast to a traditional supply chain.

Potential Chaos

A virtual supply chain can facilitate the development of innovative solutions or initiatives. However within a virtual supply chain one or two partners may be creative and proactive but it would not necessarily follow that all partners would be and much would depend on the interaction between the partners and their desires to achieve the common business objectives and to achieve mutual benefits. The virtual supply chain would enable partner organizations to try and leverage each other to gain the maximum benefits possible from the relationship. This leveraging would be dependant on good communications and based on good business reasons such as gaining market share. Common business objectives and interests of partners within a virtual supply chain may help to create an environment conducive to innovative solutions or initiatives. However any innovative activities must be balanced against the need for adequate management control. The anticipated flows of almost real-time information across a virtual supply chain should provide timely insights on market trends and thus facilitate the devising of market strategies that otherwise may not have been possible. Achieving a high degree of responsiveness within a virtual supply chain may dictate low levels of bureaucracy. However a low level of bureaucracy must be tempered with a certain degree of management control to ensure no deviation from the common business objectives. To achieve sufficient management control would require sufficient levels of staffing to ensure appropriate checks and balances to exercise control. Potential partners of a virtual supply chain may insist on sufficient management control to be in place to afford protection. However this management control should not be too multi-layered otherwise the partners may not be able to respond in a timely and responsiveness manner as expected in a virtual supply chain.

Much depends on the existing cultures within the partner organizations. If a virtual supply chain has no formal owner,

or dominant partner, and if the reporting structures are too low, within the partner organizations, then no one would really be in control or responsible. Therefore low levels of bureaucracy may not be mandatory but more of a general rule. Partner organizations with similarities in size and culture might find it relatively easy to negotiate the necessary levels of reporting structures. In contrast partner organizations with differences in size and culture may encounter much more difficulty in negotiating the necessary levels of reporting structures.

To achieve the competitive advantages from a virtual supply chain may require partners to thrive to adhere to uniform approaches to the creation, classification and retrieval of information. Although this might be difficult to achieve there is a need for clear data definitions. It should be highlighted that communications within a virtual supply chain is dependant on a common understanding of the data and without a uniform approach to data the partner organizations may find they are unable to address new requirements.

Discussion

This paper has discussed a proposed virtual supply chain. This type of supply chain differs from a traditional supply chain in that it operates within a very dynamic environment. Partner organizations in this chain would normally conduct much of their business activities via the Internet. This provides a very dynamic network of relationships that collaborate with the sole aim of offer unique products or services in a very timely and responsive manner. The issues associated with information management within a virtual supply chain have been identified, in this paper, as, the ability to provide the relevant information to all parties, knowing exactly who the partners are and their information needs, having the necessary organizational and management processes and the potential for chaos. These issues were explored with a view to minimizing their impact on the success of a virtual supply chain.

Further research could be conducted to further explore these issues and other possible issues. There also is a need to have a better understanding of the optimum models of organizational and management structures appropriate for a virtual supply chain. Studies need to be conducted on organizations participating within a virtual supply chain to determine critical organizational practices.

The integration of information systems and Internet technology can help create a virtual supply chain. However until there is a sufficiently developed research base the optimum benefits may not be derived by partner organizations.

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